CLAIMS

What is claimed is:

1   1.   A method for routing data across an enterprise network including a plurality of

2   optical burst-switched (OBS) networks, comprising:

3   receiving a data transmission request from a node in a first network identifying a

4   destination node in a second network remote to the first network to where the data is to be

5   transmitted; wherein transmission of the data requires the data to be routed along a route that

6   spans at least of portion of multiple networks, including at least one OBS network;

7   employing an external gateway protocol to route the data between egress and ingress

8   nodes of the first, second, and any intermediate network(s) along the route; and

9   employing an internal routing protocol to route the data through the first and second

10 networks and any intermediate networks along the route,

11   wherein the external gateway protocol includes provisions for updating an availability

12 of lightpath routing across said at least one OBS network.

1   2.   The method of claim 1, wherein each of the first and second networks comprise OBS

2   networks.

1   3.   The method of claim 1, wherein the route traverses at least one intermediate network

2   comprising an OBS network.

1   4.   The method of claim 1, wherein the first network comprises a non-OBS network.

1   5.   The method of claim 1, wherein the second network comprises a non-OBS network.

1   6.   The method of claim 1, wherein the OBS network comprises a photonic burst-

2   switched (PBS) network.

1   7.   The method of claim 7, wherein the OBS network comprises a wavelength-division

2   multiplexed (WDM) PBS network.

1   8.   The method of claim 1, wherein the external gateway protocol comprises an extended

2   version of the Border Gateway Protocol (BGP) that includes provisions for advertising an

3   availability of routes across at least one OBS network.

1   9.   The method of claim 8, wherein the extended version of the BGP includes an

2   extension to the path attributes in a BGP UPDATE message to enable advertisement of an

3   availability or non-availability of one or more communication paths between an ingress and

4   egress BGP router in a given OBS network, further comprising:

5   dynamically updating dynamically a routing tables for a BGP router in response to

6   route advertisements contained in a BGP UPDATE message received by that BGP router.

1   10.   The method of claim 9, wherein the extension to the path attributes in the BGP

2   UPDATE message includes an available wavelength attribute that indicates a status of the

3   current wavelength availability between neighboring OBS networks.

1   11.   The method of claim 9, wherein the extension to the path attributes in the BGP

2   UPDATE message includes an available fiber attribute that that indicates a status of the

3   current fiber availability between neighboring OBS networks.

1   12.   The method of claim 9, wherein the extension to the path attributes in the BGP

2   UPDATE message includes a connection attribute that indicates whether an a connection to

3   an OBS network is available or not.

1   13.   The method of claim 1, wherein data is routed between networks using a hop-by-hop

2   routing scheme under which current routing information is considered at each hop to

3   determine the next hop.

1   14.   The method of claim 1, further comprising co-locating an OBS label edge router with

2   an EGP route in at least one OBS networks.

1   15.   The method of claim 1, wherein data is routed between networks using a packetized

2   transmission scheme, while data is routed across an OBS network by assembling packetized

3   data into one or more data bursts and sending the one or more data bursts across a lightpath

4   spanning an ingress and egress node of the OBS network.

1   16.   A method comprising:

2   configuring a plurality of optical burst-switched (OBS) networks to enable data

3   transmission between each other;

4   modeling each OBS network as an autonomous system from an external routing

5   standpoint;

6   designating at least one edge node in each OBS network as a Border Gateway

7   Protocol (BGP) router for external routing between OBS networks and a OBS label edge

8   router (LER) for internal routing within a OBS network;

9   interchanging BGP UPDATE messages between the edge nodes that are designated

10   as BGP routers, the BGP UPDATE messages including extensions for advertising the

11   availability of PBS network routes; and

12   dynamically updating routing tables for each BGP router in response to route

13 advertisements contained in the BGP UPDATE messages.

1   17.   The method of claim 16, wherein each OBS network comprises a photonic burst-

2 switched (PBS) network.

1   18.   The method of claim 16, wherein each OBS network comprises a wavelength-

2 division multiplexed (WDM) PBS network.

1   19.   The method of claim 16, further comprising:

2   configuring a respective router operatively coupled to at least one non-OBS network

3 to enable data transmissions between said at least one non-OBS network and at least one of

4 the plurality of OBS networks; and

5   dynamically updating a routing table for each respective router in response to BGP

6 UPDATE messages received by each respective router.

1   20.   The method of claim 16, wherein said at least one non-OBS network comprises an

2 Ethernet-based network.

1   21.   An apparatus for use in an optical burst-switched (OBS) network, comprising:

2   optical switch fabric, having at least one input fiber port and at least one output fiber

3 port; and

4   a control unit, operatively coupled to control the optical switch fabric, including at

5 least one processor and a storage device operatively coupled to said at least one processor

6 containing machine-executable instructions, which when executed by said at least one

7   processor perform operations to enable the apparatus to function as a External Gateway

8   Protocol (EGP) router, including:

9   receiving lightpath route availability information corresponding to an

10   availability of a route that may be used to route data through an OBS network in

11   which the apparatus may be deployed;

12   generating an External Gateway Protocol (EGP) UPDATE message indicating

13   routing availability identifying an available route for transmitting data through the

14   optical burst-switched network; and

15   sending the EGP UPDATE message to another EGP router that is external to

16   the OBS network in which the apparatus may be deployed to advertise the availability

17   of the route.

1   22.   The apparatus of claim 21, wherein the optical burst-switched network comprises a

2   photonic burst switched (PBS) network.

1   23.   The apparatus of claim 21, wherein the optical burst-switched network comprises a

2   wavelength-division multiplexed (WDM) PBS network; and the optical switching fabric

3   provides switching of optical signals comprising different wavelengths carried over common

4   fibers that may be respectively coupled to said at least one input fiber port and said at least

5   one output fiber port.

1   24.   The apparatus of claim 21, wherein execution of the machine-executable instructions

2   performs the further operations of:

3   receiving EGP UPDATE messages from another EGP router that is external to the

4   OBS network containing a route advertisement; and

5   dynamically updating a routing table maintained by the EGP router to reflect the

6   availability of a route specified in the route advertisement.

1   25.   The apparatus of claim 24, wherein execution of the machine-executable instructions

2   performs the further operations of:

3   generating a new EGP UPDATE message identifying the availability of a new route

4   including route segments contained in an EGP UPDATE message received by the EGP

5   router concatenated with a route segment through the EGP router; and

6   sending the EGP UPDATE message to another EGP router that is external to the OBS

7   network to advertise the availability of the new route:

1   26.   The apparatus of claim 24, wherein execution of the machine-executable instructions

2   performs the further operations of:

3   receiving data including a routing request identifying a destination address to which

4   the data is to be routed;

5   selecting a route from among routing data stored in the routing table that may be used

6   to reach the destination address; and

7   forwarding the data to a next hop in the route that is selected.

1   27.   The apparatus of claim 26, wherein the apparatus comprises an ingress node at which

2   the data is received, and the data is forwarded to an egress node of the OBS network via

3   execution of the machine-executable instructions to perform operations including:

4   reserving a lightpath spanning between the ingress node and an egress node that

5   corresponds to the next hop in the route; and

6   sending the data as one or more data bursts over the lightpath that is reserved.

1   28.   The apparatus of claim 26, wherein the apparatus comprises an egress node at which

2   the data is received, and the data is forwarded to an ingress node of an OBS network that is

3   external from the OBS network in which the apparatus is deployed via execution of the

4   machine-executable instructions to perform operations including:

5   reserving a lightpath spanning between the egress node and the ingress node of the

6   external OBS network; and

7   sending the data as one or more data bursts over the lightpath that is reserved.

1   29.   The apparatus of claim 26, wherein the apparatus comprises an egress node at which

2   the data is received, and the data is forwarded to an ingress node of a network that is external

3   from the OBS network in which the apparatus is deployed via execution of the machine-

4   executable instructions to perform operations including:

5   employing an Ethernet-based protocol to facilitate transmission of the data between

6   the egress node and the ingress node.

1   30.   A machine-readable medium to provide instructions, which when executed by a

2   processor in an apparatus comprising an edge node in an optical switched network, cause the

3   switching node apparatus to which when executed by said at least one processor perform

4   operations to enable the apparatus to function as a External Gateway Protocol (EGP) router,

5   including:

6   receiving lightpath route availability information corresponding to an

7   availability of a route that may be used to route data through an OBS network in

8   which the apparatus may be deployed;

9   generating an External Gateway Protocol (EGP) UPDATE message indicating

10   routing availability identifying an available route for transmitting data through the

11   optical burst-switched network; and

12   sending the EGP UPDATE message to another EGP router that is external to

13   the OBS network in which the apparatus may be deployed to advertise the availability

14   of the route.

1   31.   The machine-readable medium of claim 30, wherein the optical burst-switched

2   network comprises a photonic burst switched (PBS) network.

1   32.   The machine-readable medium of claim 30, wherein the optical burst-switched

2   network comprises a wavelength-division multiplexed (WDM) PBS network.

1   33.   The machine-readable medium of claim 30, wherein execution of instructions

2   performs the further operations of:

3   receiving EGP UPDATE messages from another EGP router that is external to the

4   OBS network containing a route advertisement; and

5   dynamically updating a routing table maintained by the EGP router to reflect the

6   availability of a route specified in the route advertisement.

1   34.   The machine-readable medium of claim 33, wherein execution of the instructions

2   performs the further operations of:

3   generating a new EGP UPDATE message identifying the availability of a new route

4   including route segments contained in an EGP UPDATE message received by the EGP

5   router concatenated with a route segment through the EGP router; and

6   sending the EGP UPDATE message to another EGP router that is external to the OBS

7   network to advertise the availability of the new route:

1   35.   The machine-readable medium of claim 33, wherein execution of the machine-

2   executable instructions performs the further operations of:

3   receiving data including a routing request identifying a destination address to which

4   the data is to be routed;

5   selecting a route from among routing data stored in the routing table that may be used

6   to reach the destination address; and

7   forwarding the data to a next hop in the route that is selected.

1   36.   The machine-readable medium of claim 35, wherein the apparatus comprises an

2   ingress node at which the data is received, and the data is forwarded to an egress node of the

3   OBS network via execution of the instructions to perform operations including:

4   reserving a lightpath spanning between the ingress node and an egress node that

5   corresponds to the next hop in the route; and

6   sending the data as one or more data bursts over the lightpath that is reserved.

1   37.   The machine-readable medium of claim 35, wherein the apparatus comprises an

2   egress node at which the data is received, and the data is forwarded to an ingress node of an

3   OBS network that is external from the OBS network in which the apparatus is deployed via

4   execution of the instructions to perform operations including:

5   reserving a lightpath spanning between the egress node and the ingress node of the

6   external OBS network; and

7   sending the data as one or more data bursts over the lightpath that is reserved.

1   38.   The machine-readable medium of claim 35, wherein the apparatus comprises an

2   egress node at which the data is received, and the data is forwarded to an ingress node of a

3   network that is external from the OBS network in which the apparatus is deployed via

4   execution of the instructions to perform operations including employing an Ethernet-based

5   protocol to facilitate transmission of the data between the egress node and the ingress node.

1   39.   A system comprising:

2   a plurality of optical-switched networks, each including at least one edge node

3   optically coupled to a plurality of switching nodes, said at least one edge node configured to

4   perform internal routing of data within the optical-switched network that it is a member of

5   via a schedule reservation of a lightpath passing from that edge node through at least one of

6   the switching nodes to a destination node comprising one of another edge node or a

7   switching node, further wherein at least one of said at least one edge node comprises an

8   external gateway protocol (EGP) router configured to externally route data received at that

9   edge node to another EGP router located external from the optical-switched network the EGP

10   router is a member of using an external gateway protocol.

1   40.   The system of claim 39, wherein said plurality of optical-switched networks comprise

2   photonic burst-switched (PBS) networks.

1   41.   The system of claim 39, wherein at least one of the plurality of optical-switched

2   networks includes at least two edge nodes configured as EGP routers.

1   42.   The system of claim 39, wherein at least one of the EGP routers is co-located at an

2   edge node that further comprises a label edge router (LER).

1   43.   The system of claim 39, wherein the external gateway protocol comprises the border

2   gateway protocol.

1   44.   The system of claim 39, further comprising at least one external EGP router located

2   externally from each of the plurality of optical-switched networks.

1   45.   The system of claim 39, further comprising at least one non-optical switched local

2   area network (LAN).